EXPERIMENT 11: PULLEYS AND SIMPLE MACHINES

REQUIRED ITEMS

2 pulleys, string, stand with meter stick attached, for the pulleys, 1kg spring scale, 500g mass, meter tape, mass holder

PURPOSE
To investigate the properties of a pulley and its use as a simple machine

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AUTHOR____

PARTNER____

PARTNER____

BACKGROUND

A pulley is a simple machine consisting of a grooved wheel turning on an axle. Pulleys ease the amount of energy you exert by reversing the direction of force or by using mechanical advantage to increase force. Pulleys can be used singly or in combination to do work. There are three types of pulleys: fixed, movable, and compound (a combination of fixed and moveable pulleys, such as a block and tackle pulley).

The work W done by a machine must equal the work put into the machine. Thus,Wout =Win.
The work done by a pulley equals the weight it lifts times the height it lifts. The work put into the machine equals force (F) multiplied by distance (d). Thus, W = Fd orW = mgh (m= mass, g = gravity, h = height).

Mechanical advantage (MA) is the redistribution of force and distance, and is defined as the ratio of force produced by a machine to the force applied to it. Thus,

MA = Fout/Fin

There are two types of mechanical advantage: theoretical/ideal mechanical advantage and actual mechanical advantage.

Theoretical mechanical adv antage (TMA)
represents the ideal mechanical advantage of amachine, and is the ratio of the ideal output force to the ideal input force. Thus,

TMA = Fout/Fin = dout / din

Because there are no ideal machines, mechanical advantage is affected by factors such as friction.
Actual mechanical advantage (AMA)
accounts for energy loss from friction or other factors. Thus,

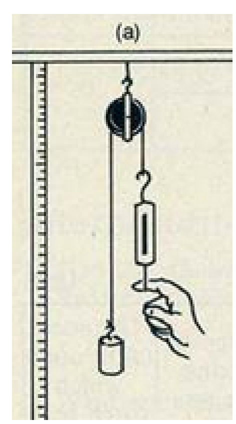
AMA= Fout/Fin with Fout = load and Fin=effort

The efficiency of a pulley is the ratio of useful work done by the pulley to the work put into the system, which is usually expressed as a percentage. Thus,

efficiency = Work out/ Work in = AMA/TMA

PROCEDURE

PART I simple pulley

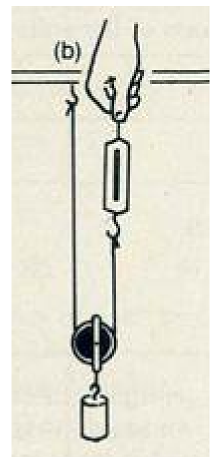


a. Suspend a single fixed pulley from a support by tying a string from the support to the pulley as shown at right.
THE TABLE TO RECORD DATA IS 2 PAGES DOWN
b. Pass a second single string through the pulley.

At the bottom end of the string attach the mass and at the other end of the string attach the spring scale.
c. Start with the mass suspended off the ground. Note the exact location of the mass and the scale. Pull on the scale until the weight rises 10 cm from its starting point. Record this as the **load distance (cm)**. Record in table 1 below.

d. Read the scale and record this as the **effort (g)** . Record the **effort distance (cm)**, which is the distance the scale moved (cm). Also, record the **load(g)** which is the mass in g that you are lifting.

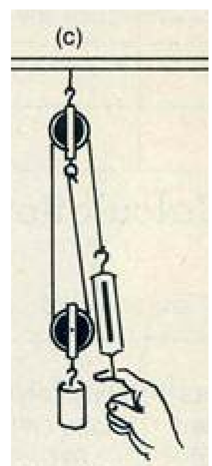
PART II Single Moveable Pulley (IMA = 2)



a. Pass a single string through the pulley as shown in the figure at right. Attach one end of the string to the support and the other end to the spring scale. Attach the mass directly to the bottom of the pulley. Note the exact location of both the mass and the scale, and record the scale reading as the **effort (g)** .

b. Lift the mass by lifting the scale. Measure the distance that the mass moves and record this as the **load distance (cm)** . Measure the distance that the scale moved and record this distance as the **effort distance (cm)**. **The load (g)** is the mass in g.

PART III Double Pulleys (IMA = 2)
a. Tie one pulley directly to the support. Tie the end of a string to the end of that pulley. Run the other end of the string around a second pulley and then up and around the first pulley. Tie this end to the scale. Attach the mass to the lower pulley. Lift the mass off the ground some distance and note the exact location of the mass and the scale.



b. Pull the scale to lift the weight farther; measure and record that **load distance (g)** Read the scale and record this **effort force (g)**. Measure and record the distance that the scale moves, t**he effort distance (cm)**.
Record the mass as the **load(g)**

TABLE 1

	Fixed pulley	**Movable pulley**	**Double pulley**
Effort (g)			
Effort distance (cm)			
load(g)			
Load distance (cm)			

ANALYSIS

1) Compute the Work in by multiplying distance effort (cm) by effort (g). The unit is erg. It is a small unit for energy.
Record in TABLE 2.

2) Compute the Work out by multiplying distance load (cm) by load(g). Record in TABLE 2.

3) Compute the efficiency (Workout/Workin) x 100. If there is no loss due to friction (as thermal energy), the efficiency is 100%.

4) Compute the mechanical advantage by dividing load/effort. This number is how stronger you get by using this machine ~!

TABLE 2

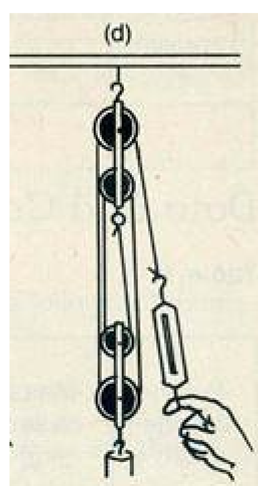
	Fixed pulley	**Movable pulley**	**Double pulley**
Work in (erg)			
Work out (erg)			
Efficiency			
Mechanical advantage			

5) Which of these machine has a MA of 1 ? So what is the point of using it ?

6) Which of these machines makes you twice as strong ? And what is the price to pay ?

7) Was your efficiency 100% ? why not ?

8) What could you do to get an efficiency closer to 100%



9) Look at the following machine@ right.
What do you think the MA is?
What is the price to pay ?

10) Try to build it and try it. Is it consistent with what you have learnt ?
Take a pic of it to include it in your lab.